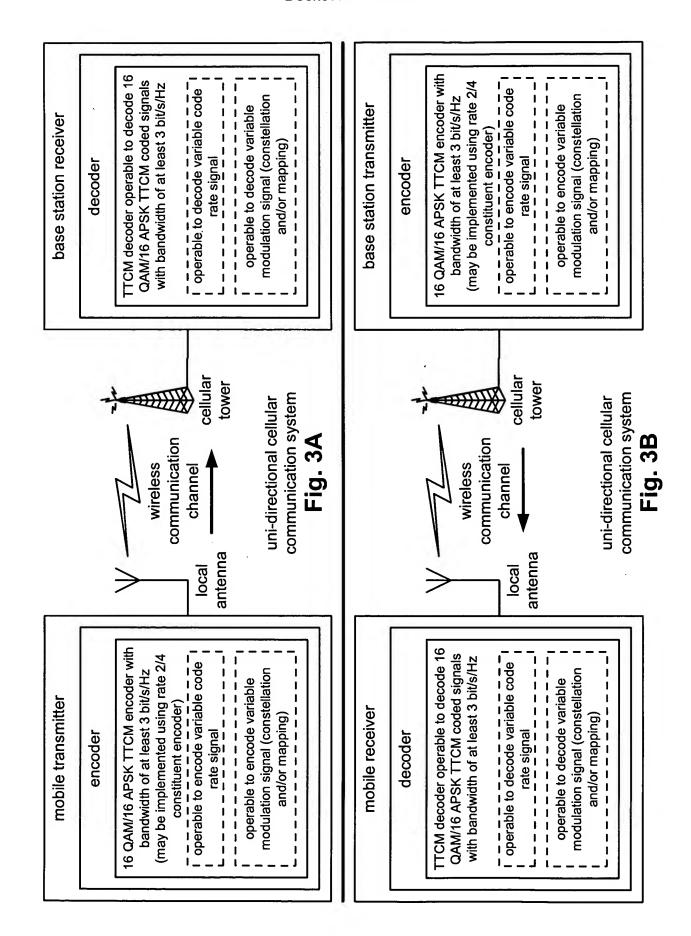
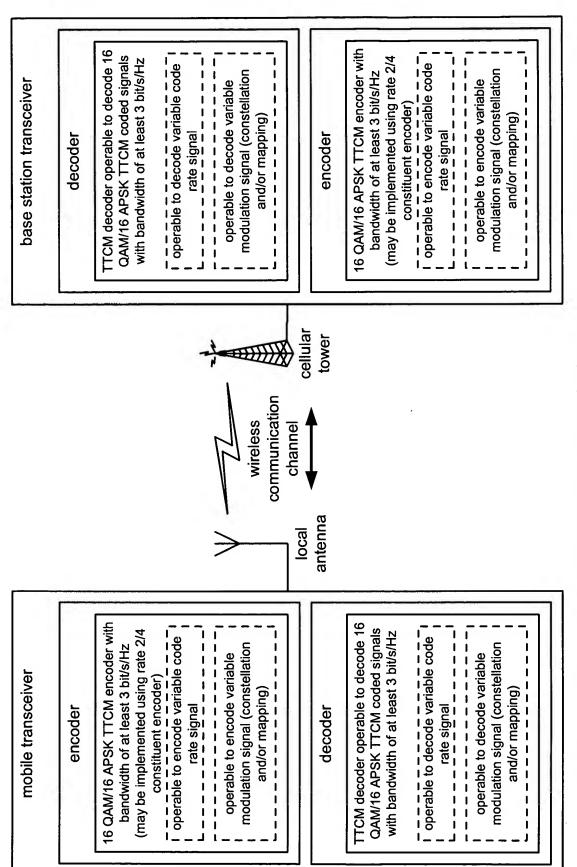
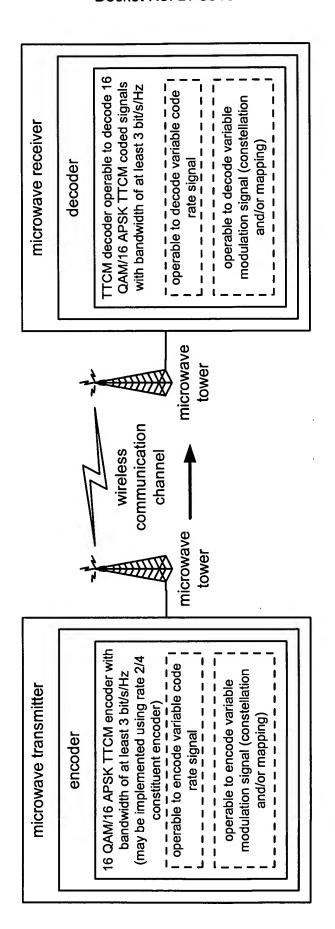


HDTV (High Definition Television) communication system

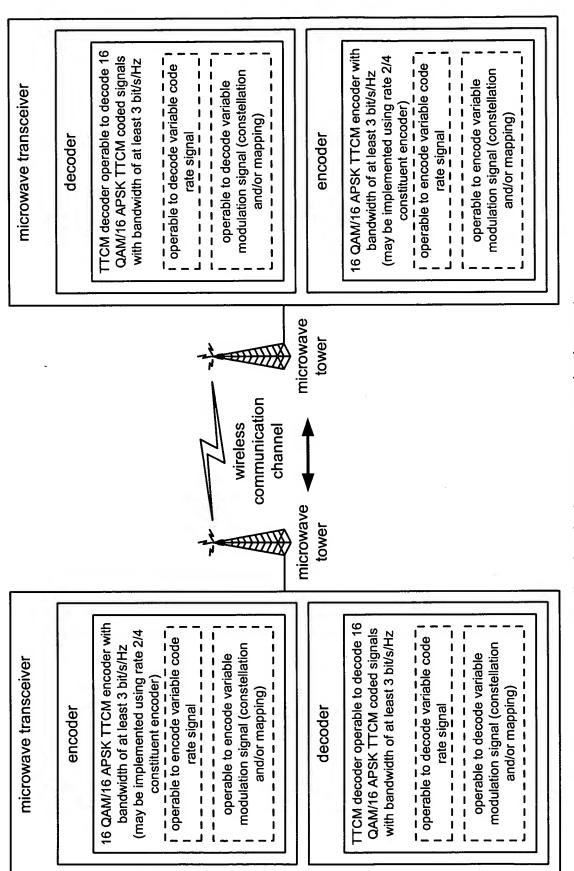




bi-directional cellular communication system

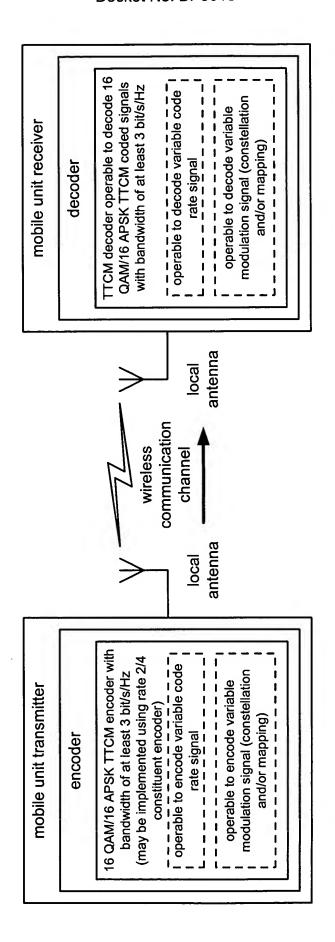


uni-directional microwave communication system



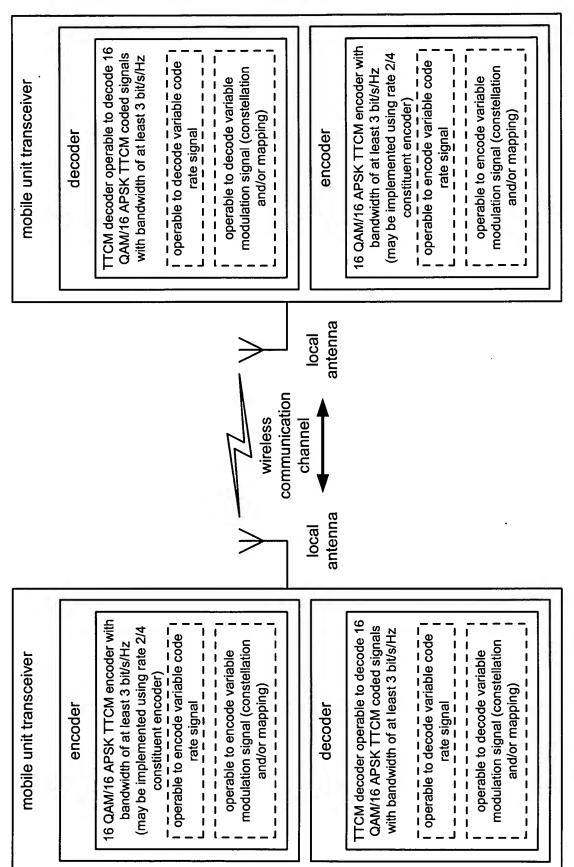
bi-directional microwave communication system

Fig. 6



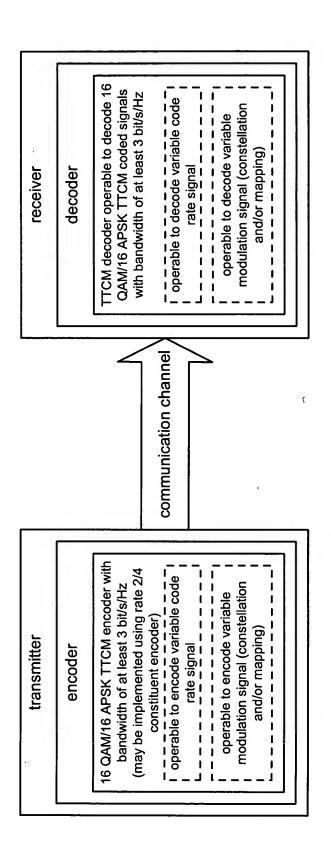
uni-directional point-to-point radio communication system

Fig. /



bi-directional point-to-point radio communication system

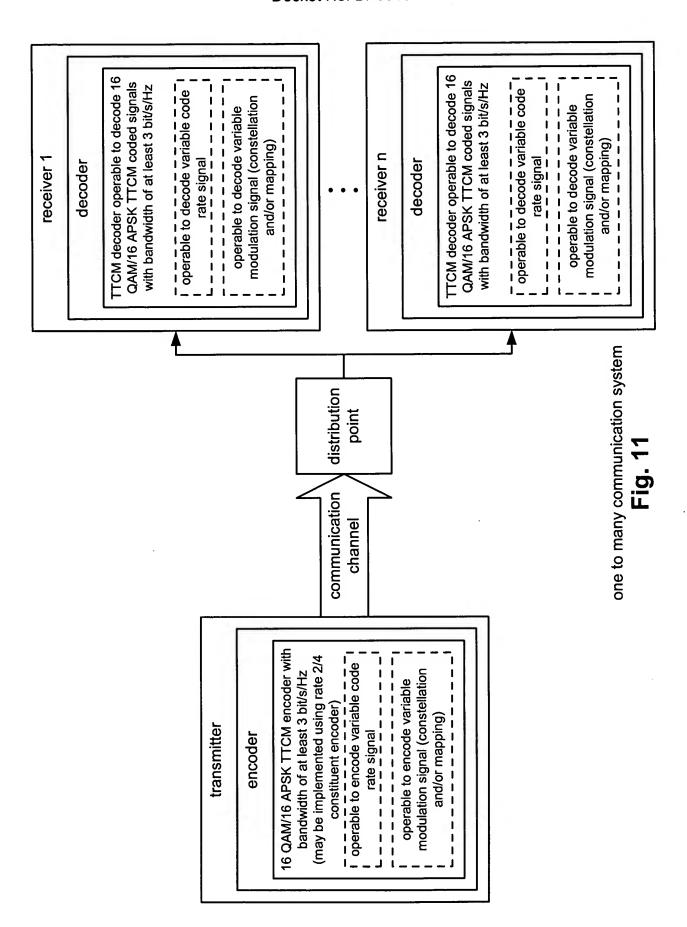
Fig. 8

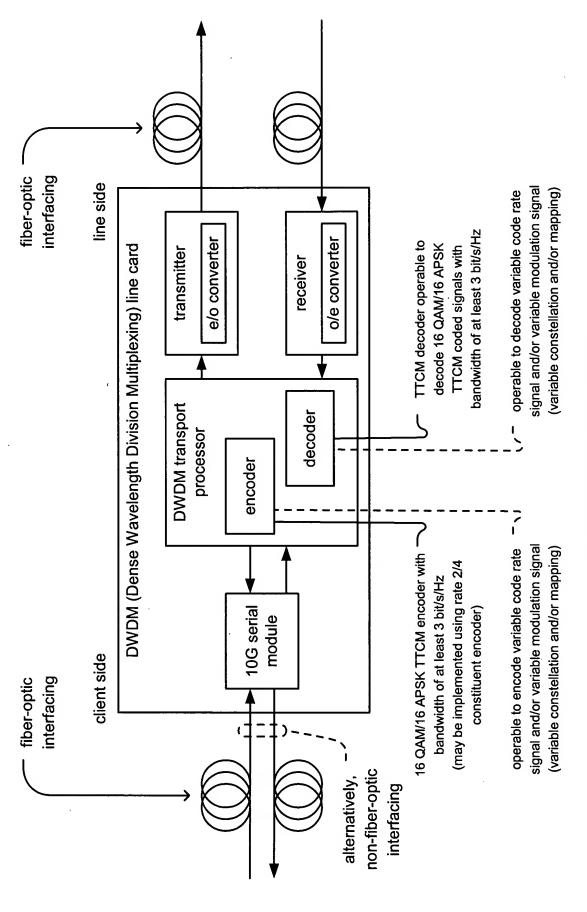


uni-directional communication system

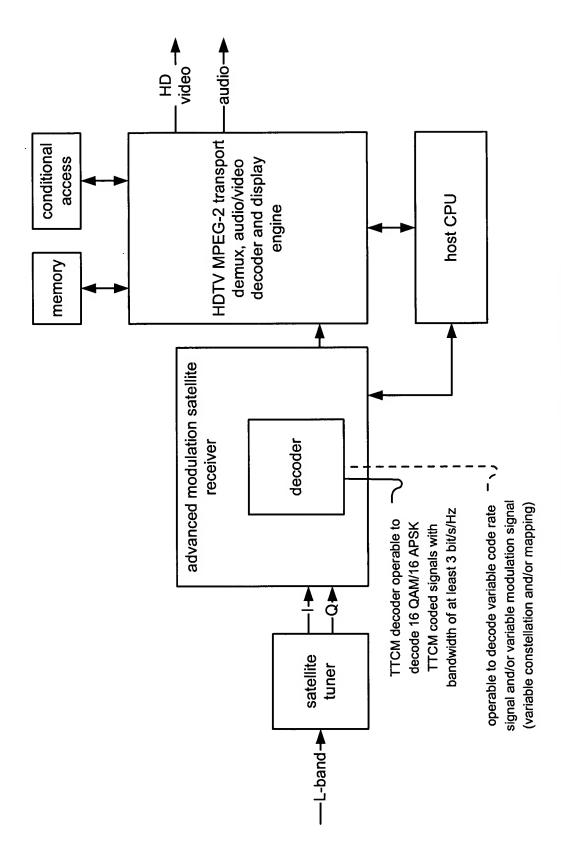
transceiver	decoder	TTCM decoder operable to decode 16 QAM/16 APSK TTCM coded signals with bandwidth of at least 3 bit/s/Hz  operable to decode variable code  rate signal  operable to decode variable  modulation signal (constellation and/or mapping)  and/or mapping)	encoder	16 QAM/16 APSK TTCM encoder with bandwidth of at least 3 bit/s/Hz (may be implemented using rate 2/4 constituent encoder)  Toperable to encode variable rate signal operable to encode variable modulation signal (constellation and/or mapping)  and/or mapping)
		communication channel		
transceiver	encoder	16 QAM/16 APSK TTCM encoder with bandwidth of at least 3 bit/s/Hz (may be implemented using rate 2/4 constituent encoder)  I operable to encode variable rate signal rate signal operable to encode variable modulation signal (constellation and/or mapping)	decoder	TTCM decoder operable to decode 16 QAM/16 APSK TTCM coded signals with bandwidth of at least 3 bit/s/Hz  operable to decode variable code rate signal coperable to decode variable modulation signal (constellation and/or mapping)

bi-directional communication system **Fig. 10** 

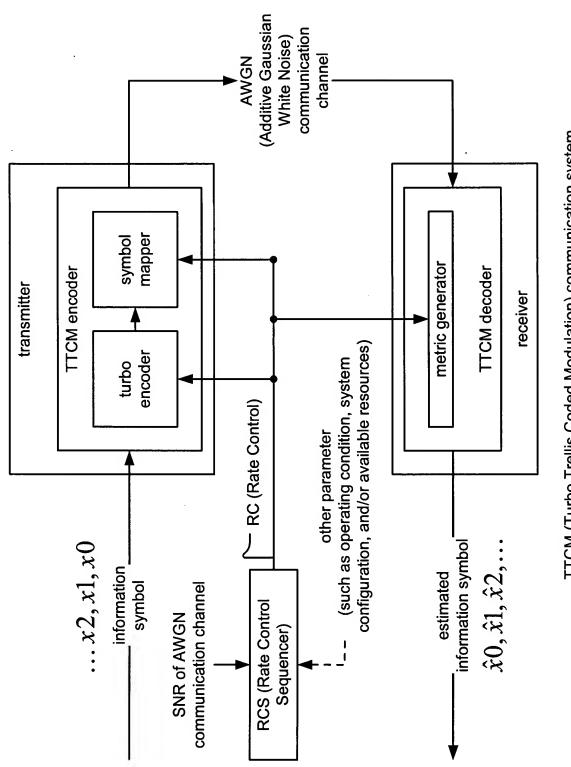




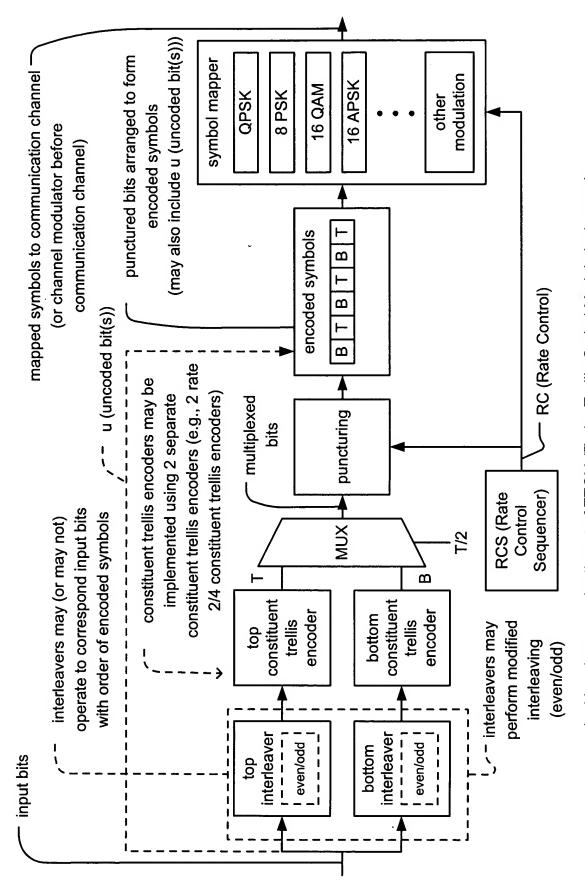
fiber-optic communication system **Fig. 12** 



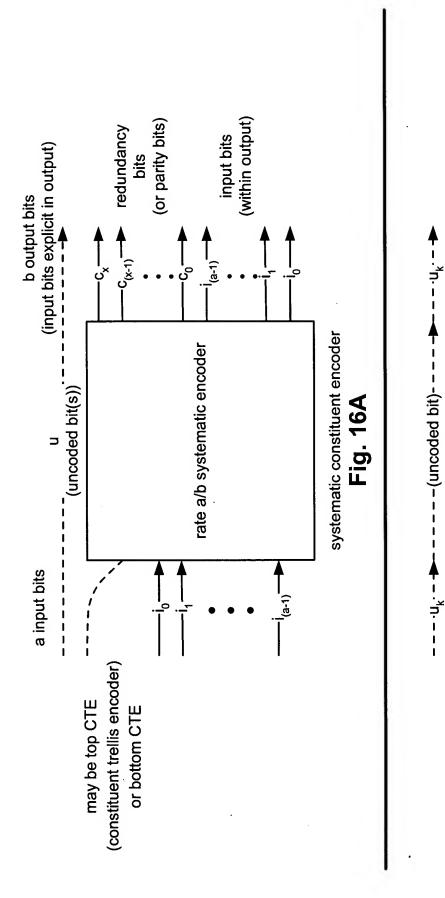
satellite receiver STB (Set Top Box) system **Fig. 13** 



TTCM (Turbo Trellis Coded Modulation) communication system **Fig. 14** 



dual interleaver embodiment of TTCM (Turbo Trellis Coded Modulation) encoder Fig. 15

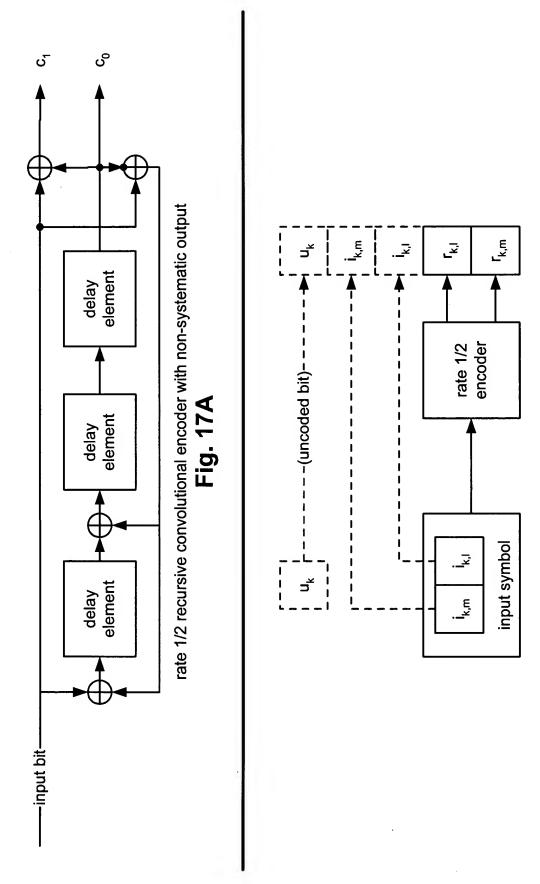


rate 2/4 constituent encoder **Fig. 16B** 

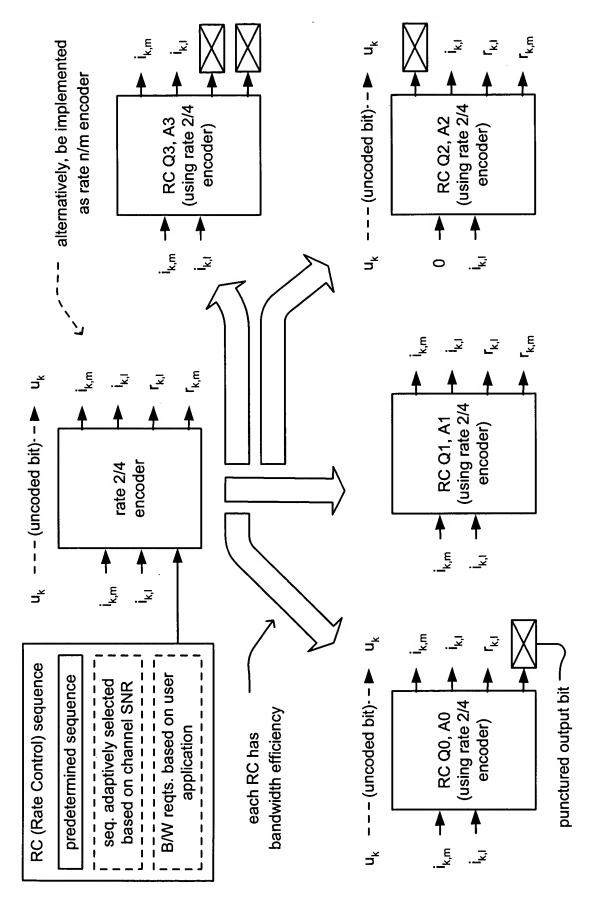
.I<sub>k,m</sub> →

rate 2/4 encoder

ا چ

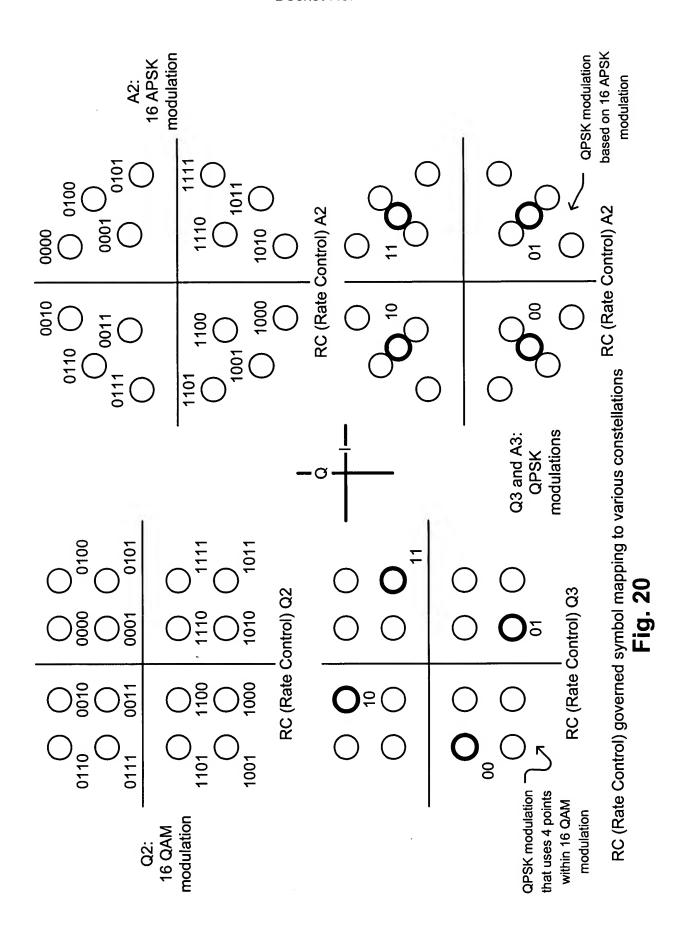


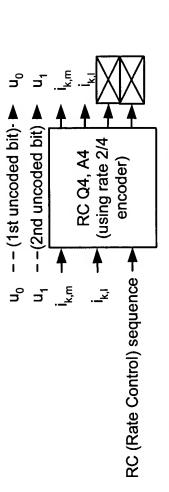
rate 2/4 prototype encoder **Fig. 17B** 



rate 2/4 prototype encoder supporting multiple encoders **Fig. 18** 

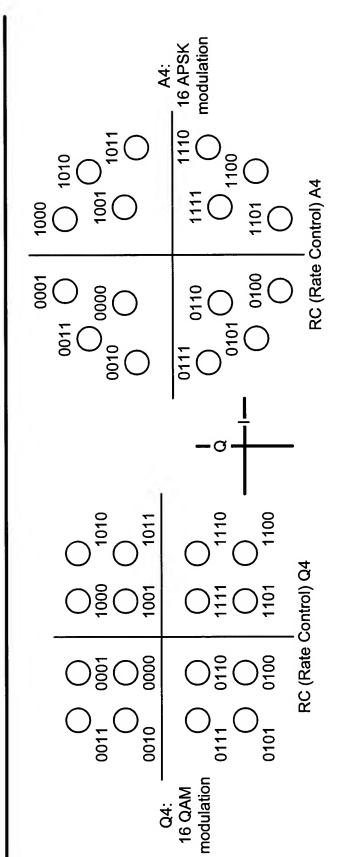
900 001 001	1111	RC (Rate Control) A0 16 APSK	000 010 010 010 010	0110 0111	RC (Rate Control) A1
0110	) 101 100 1001	RC (Rate	20 10 10 10 10 0 10 0	1111	)
		-o-	<u> </u> <del> </del>		RC (Rate Control) governed symbol mapping to various constellations <b>Fig. 19</b>
0 0 0 0 0 1 0	Ot O	Control) Q0	0% 0% 0% 013 0013	00000000000000000000000000000000000000	 RC (Rate Control) Q1 RC ( ma <sub>l</sub>
0110 0101	O <sup>101</sup> O <sup>101</sup> O <sup>10</sup> O <sup>10</sup> O <sup>10</sup> O <sup>10</sup> O <sup>10</sup>	RC (Rate Control) Q Q0 and Q1: 16 QAM	1001 1000	O <sup>111</sup> O <sup>110</sup> O <sup>110</sup> O <sup>110</sup> O <sup>110</sup>	RC (Rate 0





rate 2/4 prototype encoder supporting RCs Q4, A4 (each having 2 uncoded bits)

Fig. 21A



RC (Rate Control) governed symbol mapping to various constellations

Fig. 21B

bandwidth	a period of a s qu nce for a period of a sequenc	a period of a sequenc for 16 APSK
3.33 bit/s/Hz	Q0 Q0 Q4	A0 A0 A4
3.5 bit/s/Hz	Q0 Q0 Q4 Q4	A0 A0 A4 A4

periodic RC (Rate Control) sequences of TTCM supporting bandwidths of at least 3 bit/s/Hz Fig. 22A

coded data <del>d</del>eprocessor output interleaver interleaver -outputpossible values for <del>de</del> uncoded bits extrinsic extrinsic OSIS (ppo) bottom top (even) SISO (soft-in Soft-Out) **R**C  $R_{C}$ app <sub>|</sub> арр initialize app generator metric inputs ā pre-processing receiver extraction ā signal 쫎

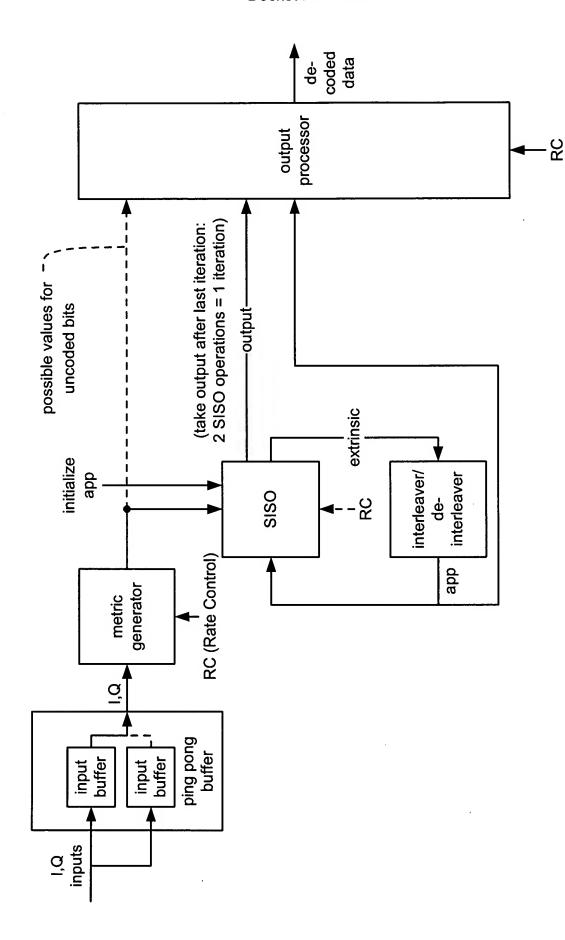
- S

(take output after last iteration: 2 SISO operations = 1 iteration)

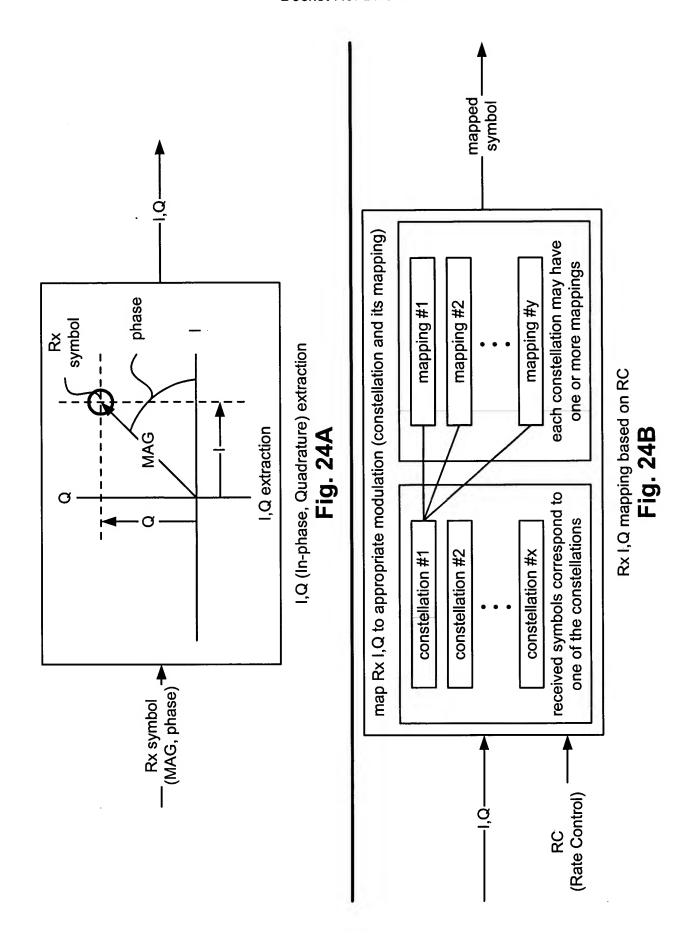
TTCM decoder system

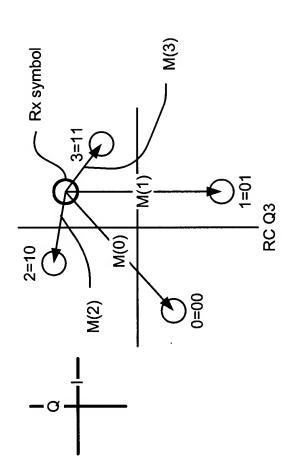
RC (Rate Control)

Fig. 22B

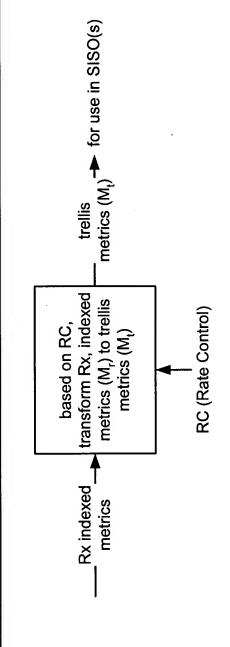


alternative TTCM decoder system that recycles single SISO (receiving I,Q inputs) Fig. 23

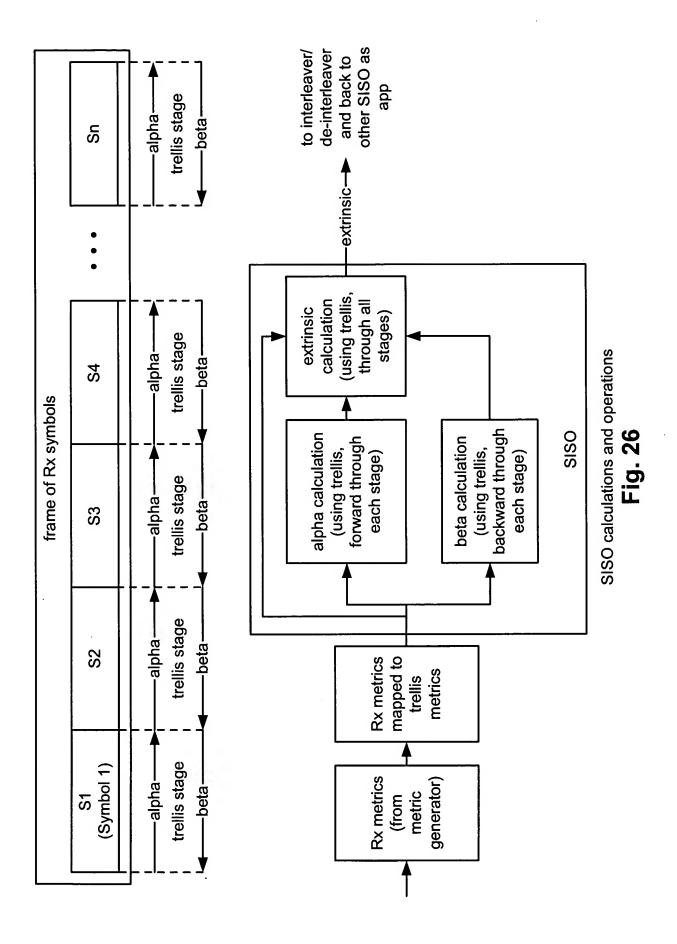


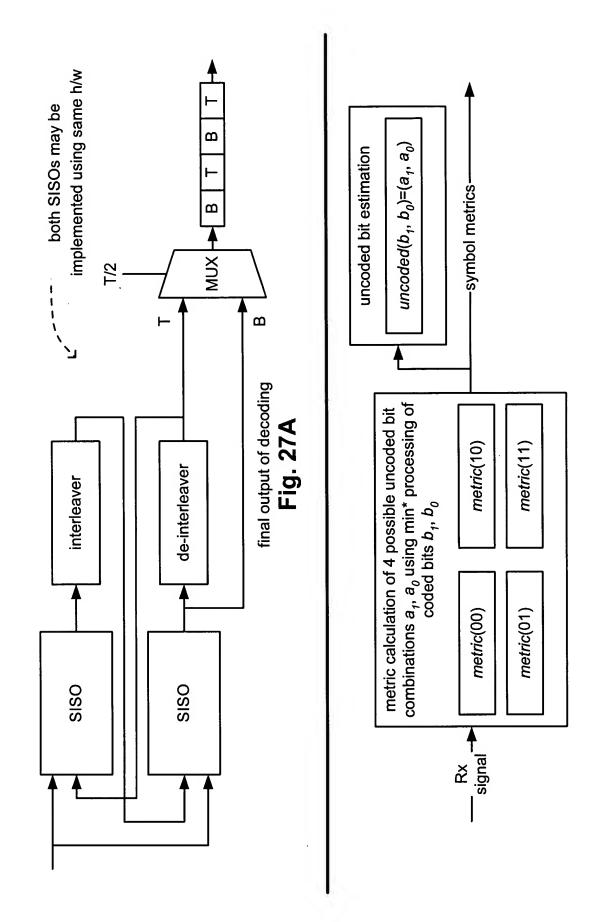


metric calculation performed by metric generator (shown for RC Q3 embodiment) Fig. 25A



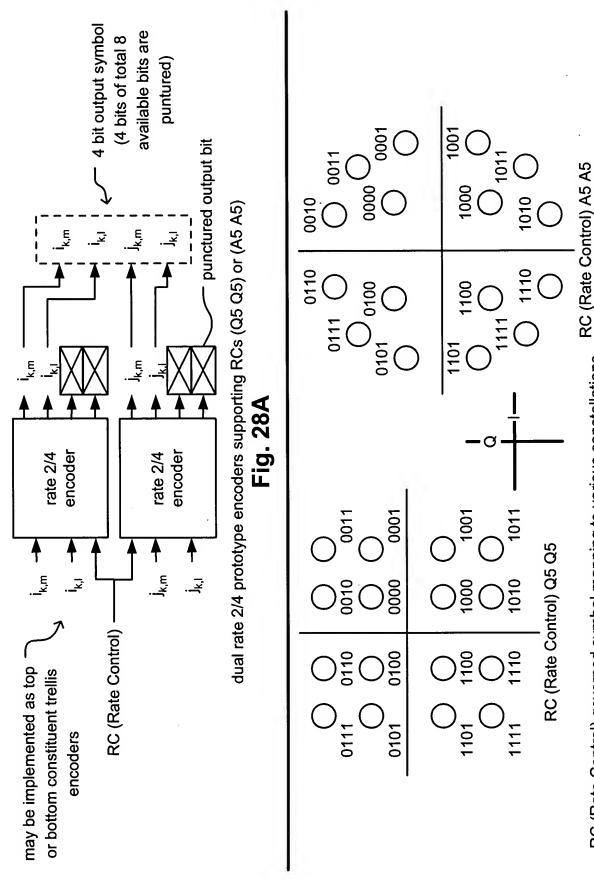
metric mapping functionality **Fig. 25B** 





metric generator computation to accommodate RCs Q4 and A4

Fig. 27B

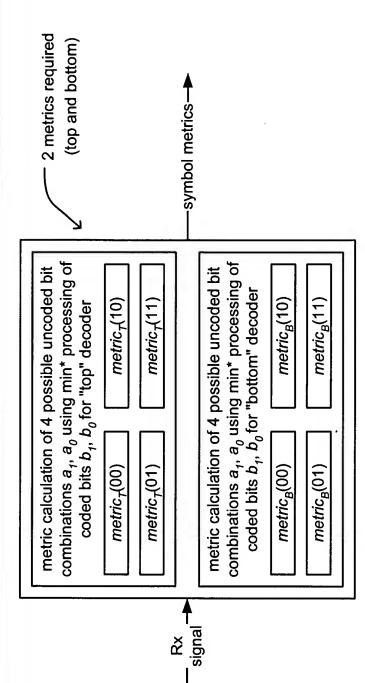


RC (Rate Control) governed symbol mapping to various constellations Fig. 28B

bandwidth	a period of a sequence for 16 QAM	a period of a sequence for 16 QAM 16 QAM
3.33 bit/s/Hz	Q0 Q0 (Q5 Q5)	A0 A0 (A5 A5)
3.5 bit/s/Hz	Q0 Q0 (Q5 Q5) (Q5 Q5)	A0 A0 (A5 A5) (A5 A5)

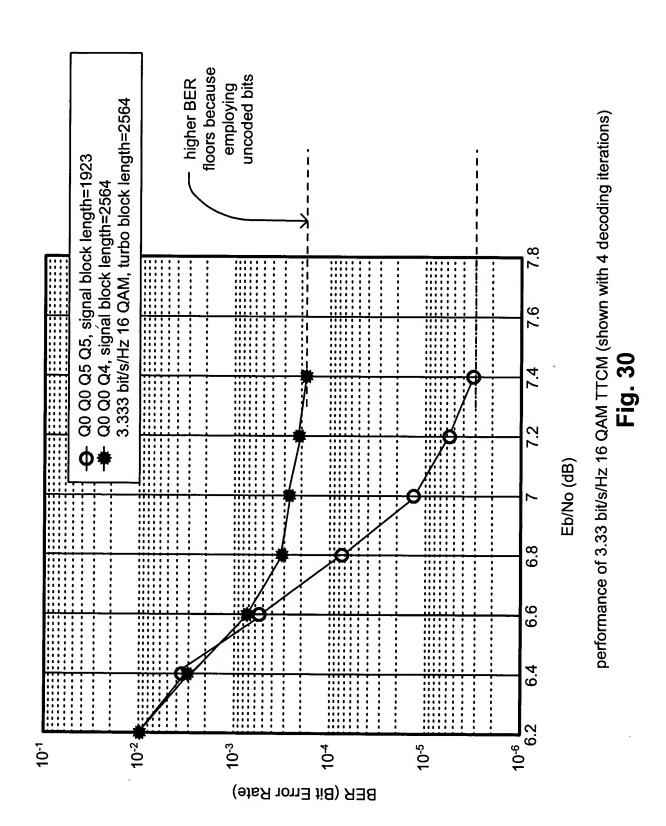
periodic RC (Rate Control) sequences supporting TTCM supporting bandwidth of at least 3 bit/s/Hz

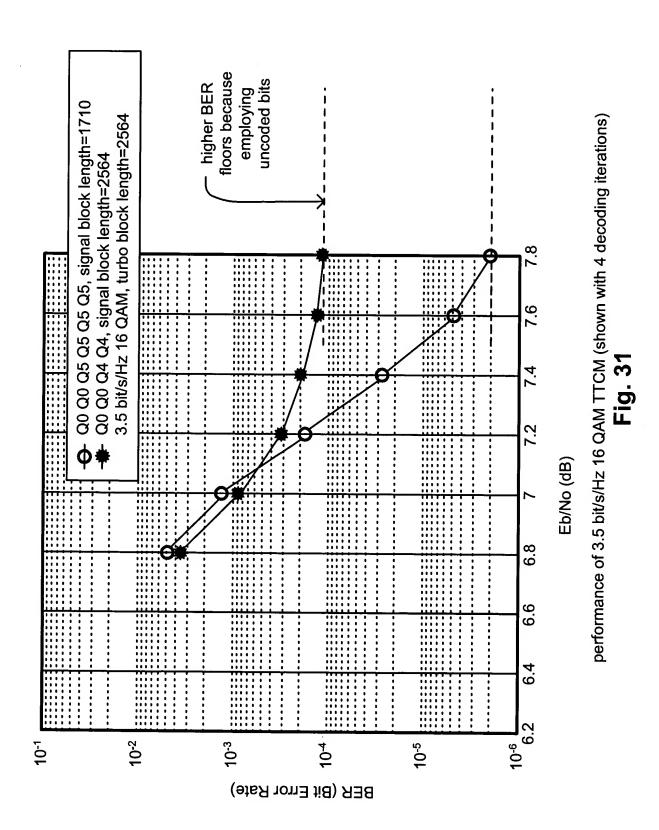
Fig. 29A



metric generator computation to accommodate RCs (Q5 Q5) and (A5 A5)

Fig. 29B





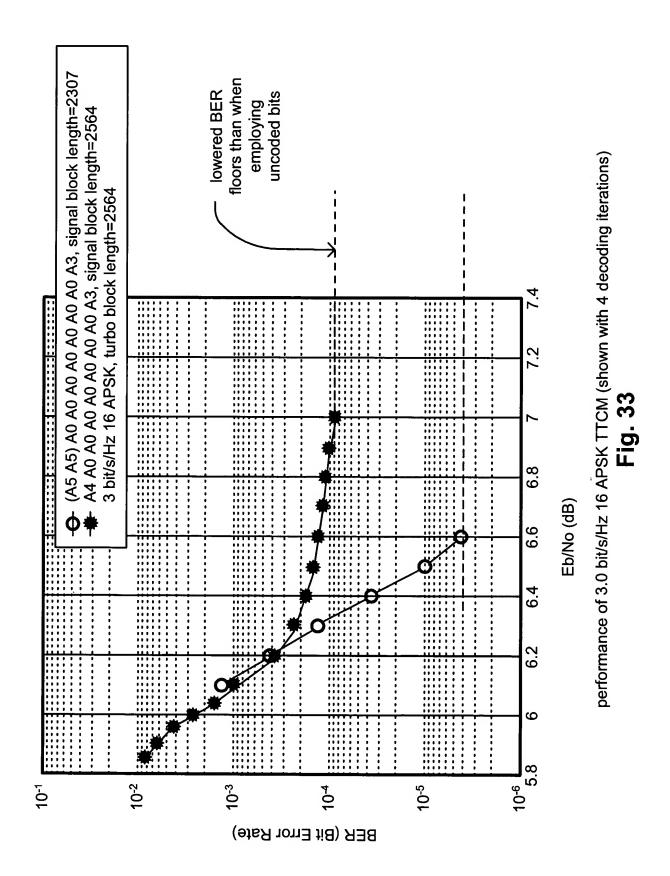
RC sequences include combined 16 QAM and QPSK (Q3) modulations

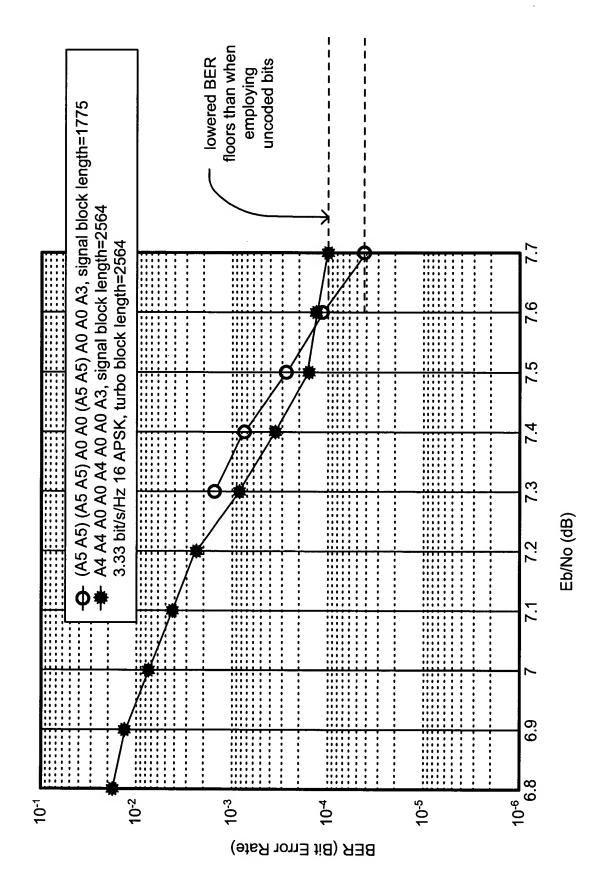
Combined 16 APSK and QPSK (A3) modulations

bandwidth	a period of a sequence for 16 QAM (period 9)	a period of a sequence for 16 QAM (period 9) a period of a sequence for 16 APSK (p riod 9)
3.0 bit/s/Hz	Q4 Q0 Q0 Q0 Q0 Q0 Q0 Q3, or (Q5 Q5) Q0 Q0 Q0 Q0 Q0 Q0 Q3	A4 A0 A0 A0 A0 A0 A0 A3, or (A5 A5) A0 A0 A0 A0 A0 A0 A3
3.11 bit/s/Hz	Q4 Q0 Q0 Q0 Q4 Q0 Q0 Q0 Q3, or (Q5 Q5) Q0 Q0 Q0 (Q5 Q5) Q0 Q0 Q0 Q3	A4 A0 A0 A0 A4 A0 A0 A0 A3, or (A5 A5) A0 A0 A0 (A5 A5) A0 A0 A3
3.33 bit/s/Hz	Q4 Q4 Q0 Q0 Q4 Q4 Q0 Q0 Q3, or (Q5 Q5) (Q5 Q5) Q0 Q0 (Q5 Q5) (Q5 Q5) Q0 Q0 Q3	A4 A4 A0 A0 A4 A4 A0 A0 A3, or (A5 A5) (A5 A5) A0 A0 (A5 A5) (A5 A5) A0 A0 A3

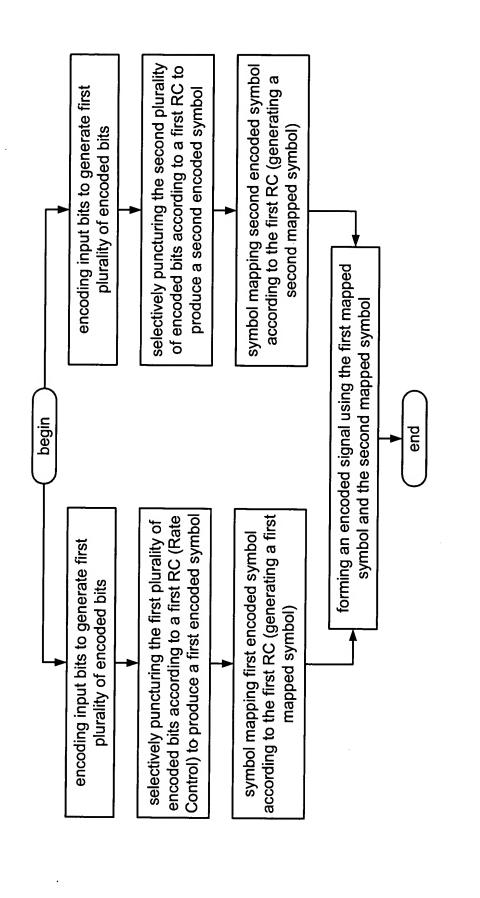
combined modulation periodic RC sequences supporting TTCM supporting bandwidth of at least 3 bit/s/Hz

Fig. 32





performance of 3.33 bit/s/Hz 16 APSK TTCM (shown with 4 decoding iterations)



TTCM (Turbo Trellis Coded Modulation) encoding method **Fig. 35** 

